Analysis of Air Operations During DESERT SHIELD and DESERT STORM

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Introduction

- ***Extended air defense simulation (EADSIM)***
- ***Hybrid Monte Carlo/deterministic simulation***
  - Army missile command (MICOM 1980s)
    - Evaluate alternative command & control
    - C^3 capabilities of systems modeled accurately
      - ? Unique aspect of EADSIM

Outline

- *Background/atmosphere*
- *Development of model prototype*
- *Using the model*
- *Results/analysis*
- *Summary*

Background/atmosphere

- ***Initial conceptual study nearly complete***
  - Alternative force structures
  - Detect and monitor drug smugglers
  - Research for a more complete database just starting
- ***August 1990, Iraqi tanks roll south***
- ***Phone at USAF studies & analysis agency (AFSAA) rings***
  - Air force director of plans (XOX) wants an attrition estimate

Background/atmosphere

- ***The response? A three pronged approach***
  - First prong - A quick look
    - Previous AFSAA study effort
    - Top level analysis methods (SWAG)
    - Objective?
      - Answer to XOX within one week

Background/atmosphere

- ***The response? A three pronged approach***
  - Second prong – TAC THUNDER
    - Check long term attrition levels (30+ days)

Background/atmosphere

- ***The response? A three pronged approach***
  - Third prong – EADSIM (unproven system)
    - Detailed mission level study
      - SAM vs. Fighter
      - Fighter vs. Fighter
    - Effects of centralized C^2
    - Graphic playback of the results
      - Watch the battle unfold

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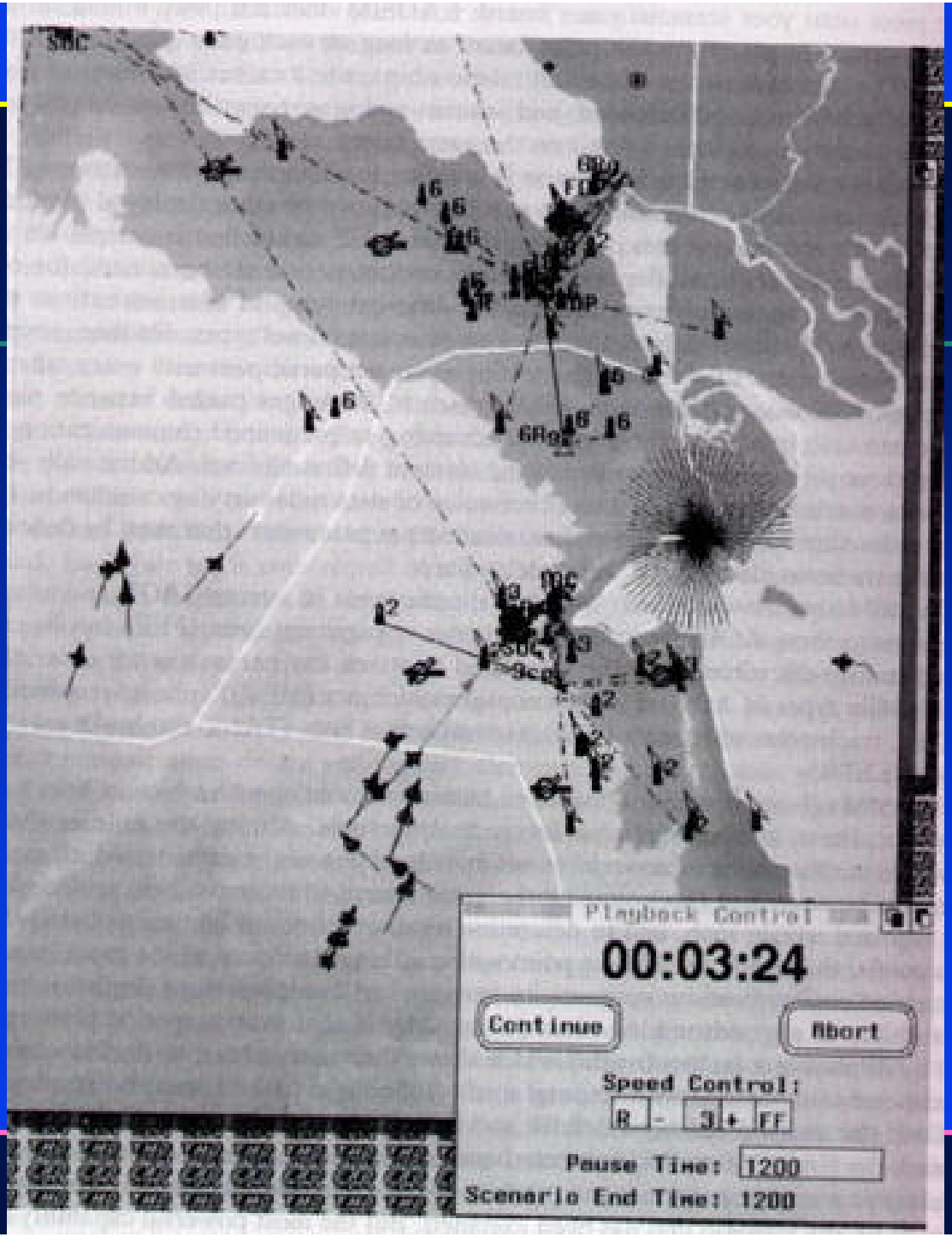


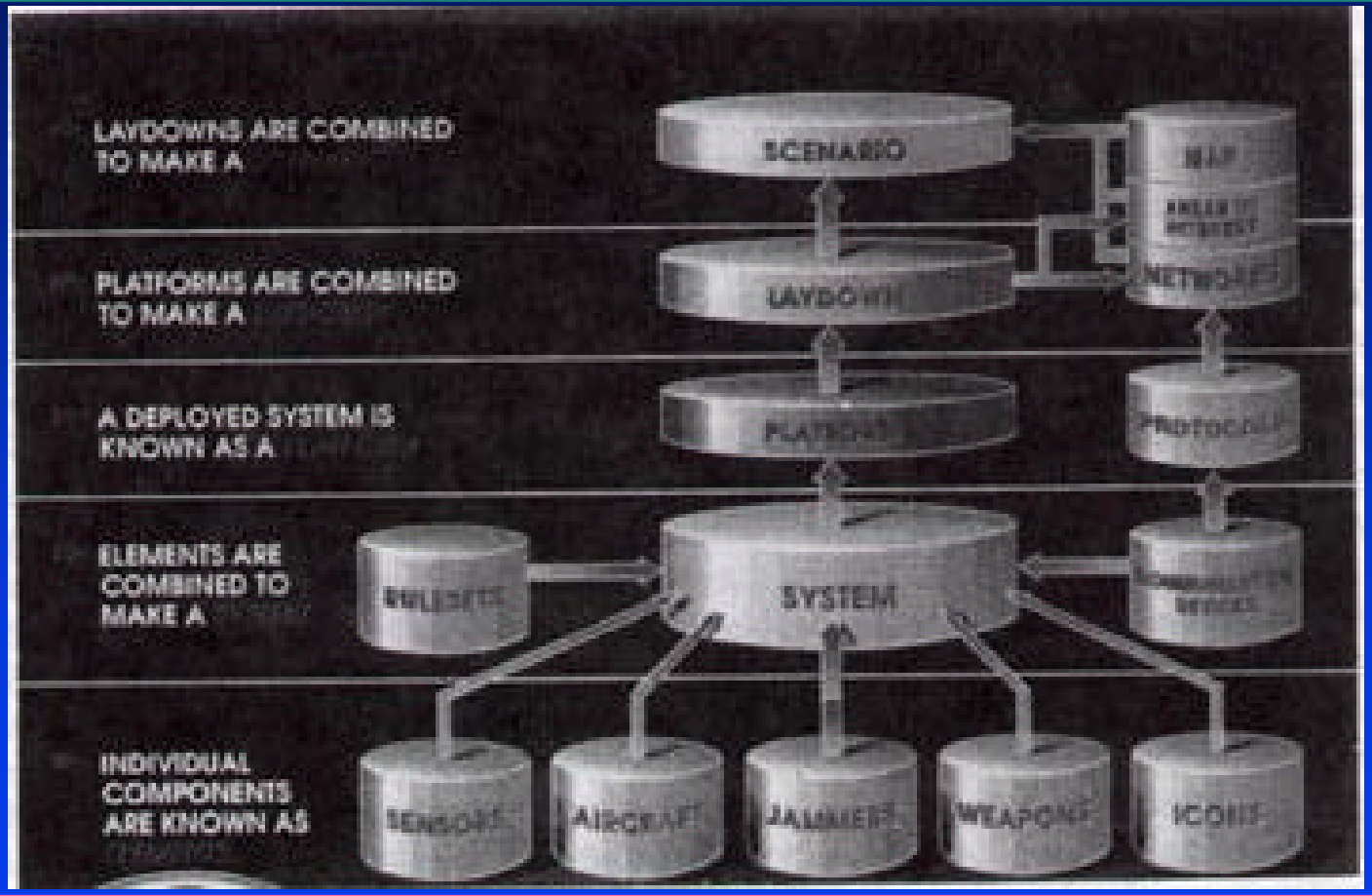
EADSIM Scenario

- ***First step***
  - Identify and determine how to represent game pieces and their interrelationships
    - How each game piece interacts with its commanders and subordinates

EADSIM Scenario

- ***Second step***
  - Make sure you have all the necessary pieces you need to build the scenario
    - Element
    - System
    - Platform
    - Laydown
    - Scenario

EADSIM Scenario



EADSIM Scenario

- ***Element***
  - The lowest level EADSIM player piece
    - Seven types
      - Aircraft
      - Communications devices & protocols
      - Jammers
      - Rule sets
      - Sensors & weapons

EADSIM Scenario

- ***Aircraft element definition***
  - User defined aircraft flight characteristics
    - Must provide a unique name to each definition
    - Three degrees of freedom flight dynamics

EADSIM Scenario

- ***Sensor element***
  - User defines a particular sensor (APG-70)
    - Unique name per sensor type
    - User provides all necessary parameters to describe the sensor

EADSIM Scenario

- ***Sensor element***
  - Six types are modeled in EADSIM
    - Radar
    - SIGINT, IMINT, HUMINT
    - Launch detector
    - Radar warning receiver
  - Required parameters vary by system

EADSIM Scenario

- ***Weapons element***
  - Specific weapons defined here (SA-2, Mk 82, etc…)
    - Parameters include:
      - How it is carried
      - Targets it is effective against
      - Pk value
        - Default composite
        - Target specific

EADSIM Scenario

- ***Rule-Set element***
  - Rule-set class (framework)
  - Rule-set characteristics
    - How many targets can be tracked, etc..
  - Rule-set phases
    - How long it takes to initiate a particular action
    - Exact time taken to complete a phase is determined by a Monte Carlo draw at run time

EADSIM Scenario

- ***Systems***
  - Made up of elements
    - F-14
    - AWG-9
    - AIM-9
    - UHF Radio

EADSIM Scenario

- ***Platform – Unique names***
  - Deployed units
    - Tomcat 01
    - Tomcat 02
    - Prowler 01
    - Hornet 01
    - Hornet 02

EADSIM Scenario

- ***Last step in building a scenario***
  - Communication nets
    - Series of nets between 2 or more platforms
    - Must have compatible gear
    - Seven types are modeled
      - Landline, duplex, broadcast, etc…
  - Areas of interest (MEZ, FEZ, AOR, etc…

Development of Prototype EADSIM Modification

- ***Extensive research to ensure accurate depiction of the equipment.***
- ***Model Iraqi KARI Command and Control system***
  - Joint intelligence agencies (Joint Intelligence Center)

Development of Prototype Shortfalls

- ***EADSIM User Interface:***
  - Laying site locations and building C3 network made difficult by EADSIM's non-user friendly interface.
- ***Simulating Air Operations in a realistic manner: Outside software engineer contracted.***
  - Realistic fighter reaction
  - Time saving input features (e.g. Lat/Long converter)

Development of Prototype Beyond On-site Fixes

EMCON - "Major fidelity limitation"

- Radars modeled as continuously radiating
- Obstructed the modeling of a "truly effective integrated air defense system (IADS)"
- Remains a system drawback

Perfect correlation of targets

- Not obtainable in the model
- Considered worst-case situation
- "Acceptable limitation"

Development of Prototype Beyond On-site Fixes

- ***Average single-shot P_k's***
  - EADSIM does not consider altitude, speed, or aspect angle in P_k
  - Consider worst-case situation
  - "Acceptable limitation"

Development of Prototype Model the Allied Attack Plan

- ***Available Information for modeling***
  - Available Master Attack Plan was “sketchy at best”
    - Targets, time over target, number and type of aircraft…
  - EADSIM required much more detailed information
    - Input required (target name, location, actual route of flight attacking aircraft, target weapon, employment tactics, tanker refueling routes, defensive aircraft orbit locations, etc.
  - Simplifications would be required.

Development of Prototype Model the Allied Attack Plan

- ***Simplifications – Iraqi forces***
  - Iraqi air force would not be a factor during the opening stages of the attack.
  - Aim fire AAA, while initially not considered a factor, was added in November, barrage fire AAA was never modeled.
- ***Modeling Fuel Consumption***
  - EADSIMs capability – “marginal at best”
  - Started and stopped attackers at their AAR’s (air refueling drop-off points in northern Saudi Arabia)

Development of Prototype Model the Allied Attack Plan

- ***Modeling Fuel Consumption***
  - Assumed attackers, had enough fuel to accomplish scheduled mission (viewed as a reasonable assumption)
  - Inaccurate fuel consumption had a larger impact on air to air engagements. (never corrected)
- ***Operational Losses***
  - Assumed no operational losses within the attack plan. (If 16 planes took off, 16 planes attacked)
  - Very unlikely in real-world operations.

Executing the Simulation Prototype Observations

- ***Attack scenario choreographed against Iraqi target set.***
- ***Objective: estimate of both Blue and Red losses.***
  - Engagement outcomes probabilistic, multiple runs required
  - Matched initial estimate of AFSAA's analysis
- ***Passed the "gut check"***
  - Graphical output of simulation observed by expert tacticians

Executing the Simulation Prototype Observations

- ***EADSIM's message:***
  - Highest loss rates on packages attacking heavily defended areas with insufficient SAM suppression support. – any aviator could have told you that!
  - This acted as the model's validation.
  - Additionally – simulation runs identified the most lethal SAM sites based on targeting strategies.
- ***Offered the ability to run varying force levels, target packages and strategies.***

Why Us?

AFSAA recommended us to CENTAF Special Projects

- AFSAA
  - EADSIM has “[excellent] use in developing and evaluating air operations…[including]…SEAD …’hot spots’…vulnerability in Iraqi IADS…”
- CENTAF
  - “…accept your offer…soonest…”

The Team

AFIT Trained Analyst and F-111 Squadron Commander

- Lieutenant Colonel Mike Carpenter

EADSIM Analysis Team Leader and F4 WSO

- Major F. T. Case

EADSIM Threat Expert, Intel Analyst, and NPS Grad

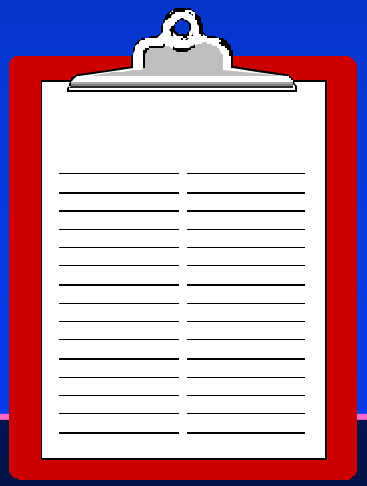
- Major Steve Satchwell

EADSIM Expert, AFIT Grad and AWACS Weapons Controller

- Captain Mike Burnes

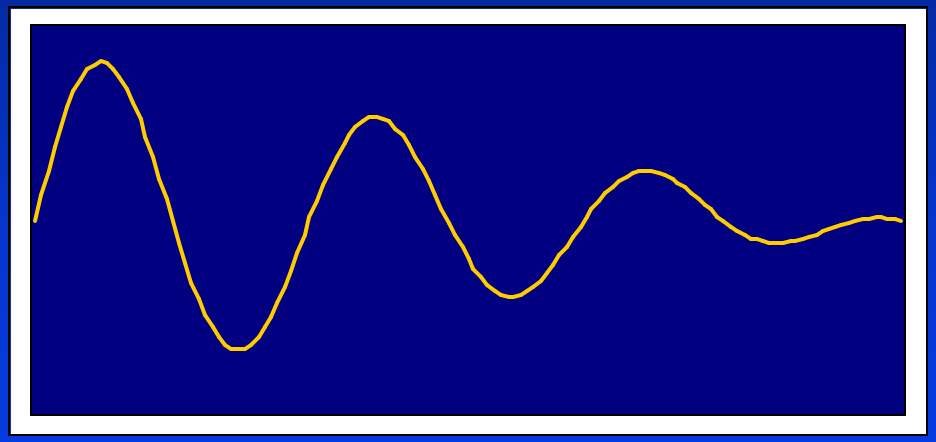
Initial Tasks

- Capture Allied mission data and convert to EADSIM format
- Develop forms and spread sheets for data collection
- Rapidly implement EOB, MOB, ATO changes as they occur
- Generate appropriate threat IADS
  - Took two weeks
- Initial run for 3 hours took 8 sim hours



Stabilization

- Multiple runs required for stabilized results
- 10 runs seemed to provide stabilized results



- Each “laydown” was time intensive

Scenario Laydowns

- Each wave of attack was essentially a “laydown”
- Multiple runs of each laydown would provide inputs for next laydown
  - Some scenarios might have multiple laydowns to allow for uncertainty

Initial Observation

Hot Spots

- A-6s being lost downtown
  - Analysis: poor idea to send low-stealth
- F-15Es lost at SCUD site
  - Analysis: change approach pattern
- Area requiring more SEAD assets
  - Analysis: when avail direct SEAD to area

Verification and Validation

Major General May asked:

- "…why we thought this model was any good."

Our response:

- "…it passed our gut check!"
  - The reality was that we had "thoroughly researched the inputs and we've watched the outputs. They make sense."

DESERT SHIELD Analysis

Determine problem areas with AAR

- Choreograph planned flows
- Define block of airspace
- Count A/C in blocks over specific increments

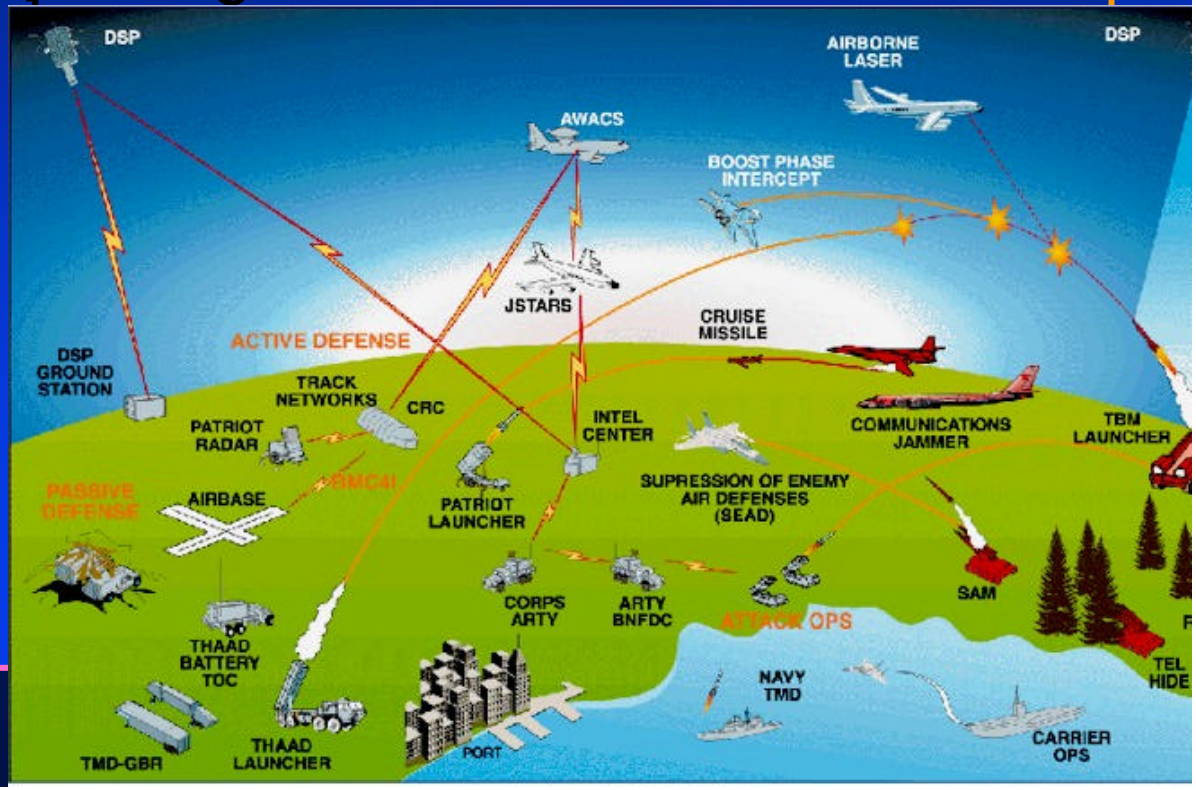
Software mods required

- Use WAN to rapidly receive mods

DESERT SHIELD Analysis

Other Aids

- Effects of changing package mix



DESERT STORM Analysis

Real-time action planning appeared useless

Restricted to side-tasks

- Regional activities
- Analyze specific A/C losses
  - F-15E lost to ??? → SAM
- Analyze tactical and operational concepts

Intel system delays proved difficult

DESERT STORM Analysis

Irrational action by Iraqi NOT modeled

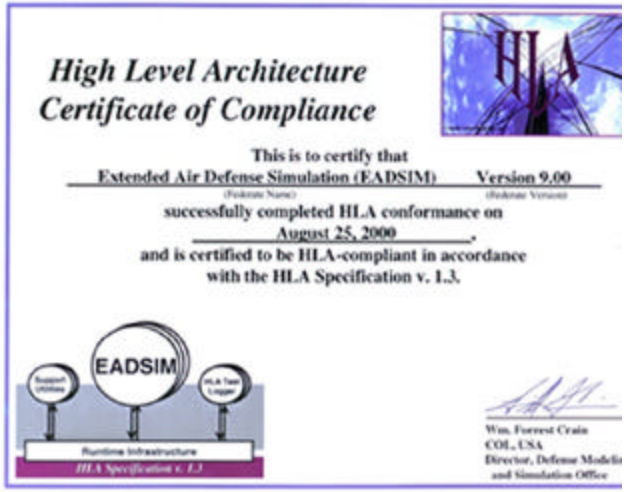
- Missiles in unguided mode
- No shots inside kill envelope

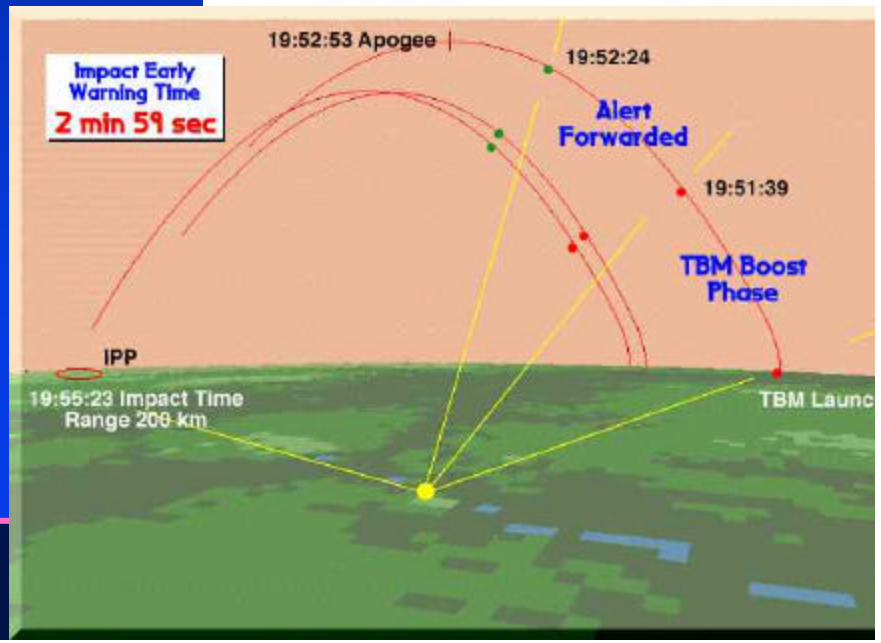
Unexpected realization

- A/C do NOT fly exactly on planned route

Where Are We Now!

- HLA compliant
- Heavily scrutinized by BMDO
- Structured training courses available
- Continuously updated
- Enhanced 3D graphics
- Multiple interfaces
  - VIC, CBS, BRAWLER, etc.
- Multi-PC platforms





Summary

Weak Links

- Did not model tactical EMCON
- Target correlation was perfect
  - This provided worst case scenario
- Probability of Kill did not account for aspect
- A/C fuel consumption model was poor
  - Utilized multiple laydowns
- No operational losses in attack plan
  - All sorties filled

Summary

Future requirements

- Automated tools must be fused with model
- All levels of command can benefit from models

Lesson Learned

- "…[sim] models do have potential for effective use in an operational environment."

Resources

- *EADSIM Web Site: www.eadsim.com*
- *EADSIM Executive Summary (PDF format)*

Questions

- EADSIM is an Air Force combat model designed for long-term campaigns. (T/F)
- The operational losses portion of the EADSIM model analysis was a key factor of EADSIM success during DESERT SHIELD. (T/F)
- Why wasn't EADSIM utilized for real-time strike planning during DESERT STORM?

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Questions?